Life Sciences Facilities

Johnson Space Center

April 27, 2000

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Topics of Discussion

- The Space and Life Sciences Directorate
  - ✓ SLSD Mission
  - ✓ Responsibilities
- Bioastronautics Initiative
- Critical Path Roadmap Project
- Bioastronautics Facility

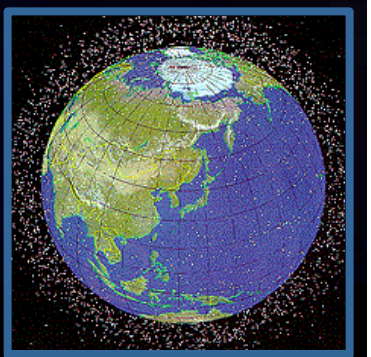
Space & Life Sciences Directorate

The mission of the Johnson Space Center is
the expansion of a human presence in space through exploration and utilization for the benefit of all

The mission of the Directorate is to be the world's leader in understanding the space frontier and the opportunities, capabilities, and limitations of humans living and working on that frontier

- . . . for the Human Exploration and Development of Space
  - **Space Medicine**
  - **Space Biomedical Research and Countermeasures**
  - **Advanced Human Support Technology**
- . . . in Astromaterials
  - **Galactic and solar wind**
  - **Interplanetary dust**
  - **Materials from comets, asteroids & other planetary bodies**

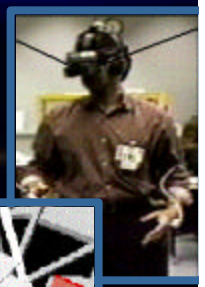
SLSD Responsibilities

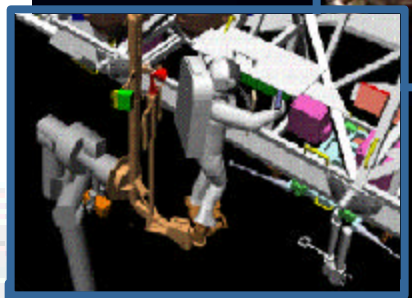


Orbital debris

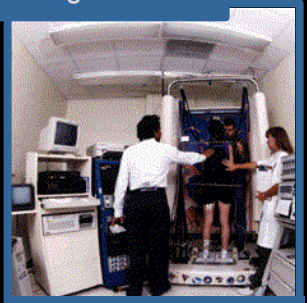
Evaluation of a workstation layout using a 95th percentile human model

- ✓ Biomedical research and countermeasure program
- ✓ Space medicine
- ✓ Occupational medicine and environmental health
- ✓ Human support systems
- ✓ Science payloads management
- ✓ Biotechnology cell science
- ✓ Space science
- ✓ Advanced human support technologies
- ✓ Program management and integration
- ✓ Safety and VPP





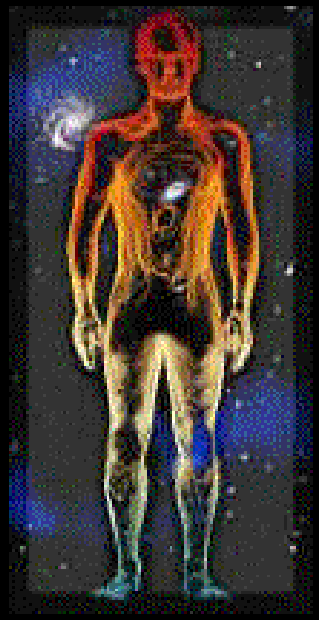
Evaluation of ISS truss structure using HVES



Computerized dynamic posturography test system

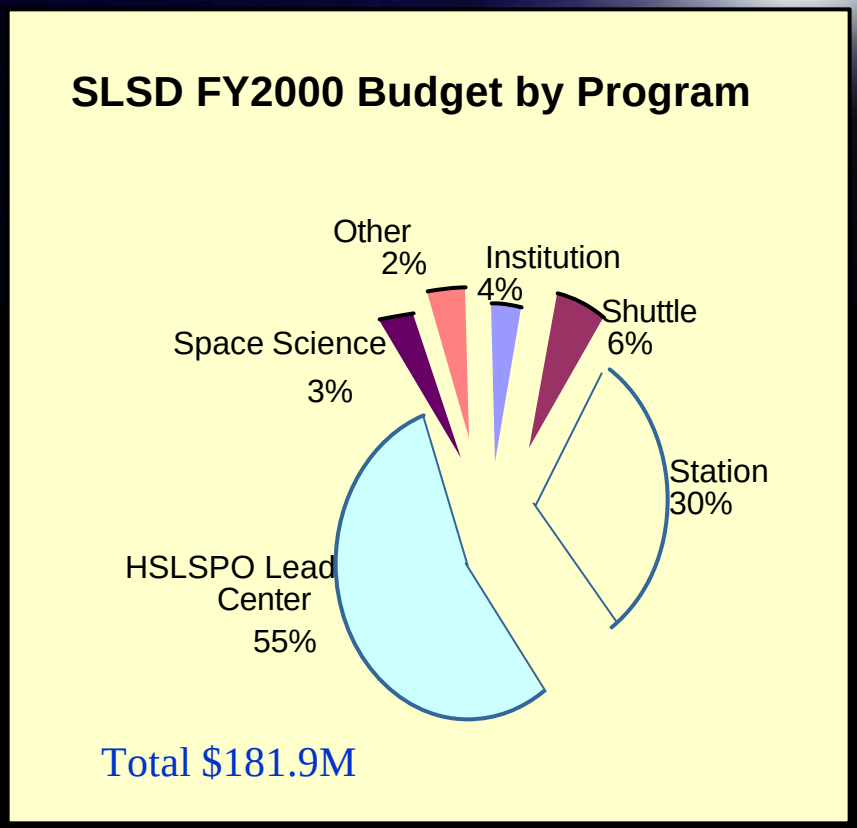
SLSD Personnel

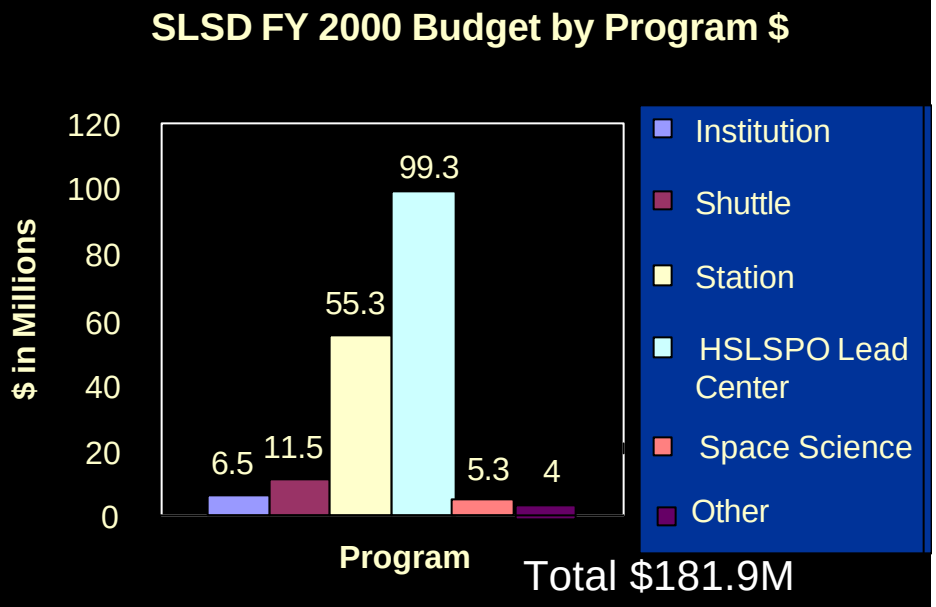
		Civil Servants	Contractors
SA	Directorate Office	18	0
SD	Medical Sciences Division	53	452
SF	Flight Projects Division	54	300
SL	Program Integration Office	13	41
SN	Earth Science & Solar System Exploration Division	44	108
Total		**182**	**901**



As of 3/00

SLSD Budgets





Facilities & Labs

Medical Sciences Division

- Cardiovascular Lab
- Clinical Operations Lab
- Muscle Res. Lab
- Bone Lab
- Exercise Physiology Lab
- Microbiology Lab
- Cellular Molecular Lab
- Environmental Physiology Lab
- Neuroscience Labs
- Nutritional Biochemistry Lab
- Water Lab
- Pharmacology Lab
- Radiation Biophysics Lab
- Toxicology Lab
- Human Test Subject Facility

Flight Crew Support Division

- ✓ Human Factors Labs
- ✓ Food Lab

Earth Science/Solar Exploration Division

- ✓ Astromaterials Lab
- ✓ Earth Sciences Lab
- ✓ Photo Analysis Lab
- ✓ Orbital Debris Lab
- ✓ Radiation Lab

Bioastronautics

History

- In mid-1999, the Space and Life Sciences Directorate was challenged to develop a new paradigm for NASA human life sciences
  - A new thrust - Bioastronautics - was formulated with a budget augmentation request
    - Expanded extramural community participation through the National Space Biomedical Research Institute
    - Initiated the detailed planning and implementation of Bioastronautics
      - *An Integrated Approach to Ensure Healthy and Safe Human Space Travel-*
      - *While Assisting in the Solution of Earth-based Problems*

Bioastronautics Defined

Builds upon previous and ongoing work

- A significant amount of fundamental knowledge has been created through ground and flight biomedical research
- It is now appropriate to apply this knowledge base to applications and solutions which will provide safer human operations in space

Utilizes new research resources

- ISS research opportunities
- Ground analogs

- Leverages new and unique capabilities
  - NSBRI established to fulfill NASA's original vision for science institutes
  - Leverage the scientific community to focus on NASA issues, transfer knowledge to Earth based problems
  - Cooperate with other Federal Agencies
  - Develop new technologies - smart medical systems, biologically-inspired technologies

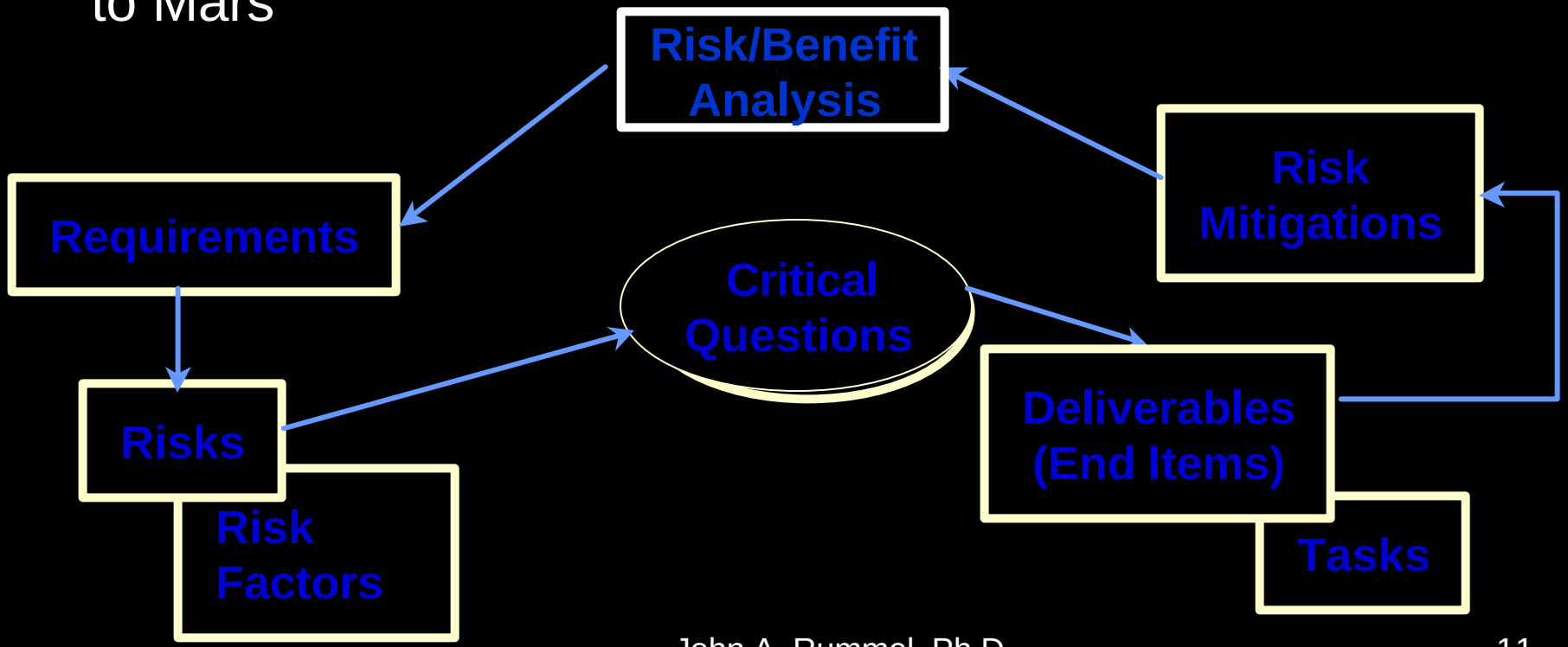
Critical Path Roadmap Project

Reducing the Risks for Human Exploration-class Missions

- To the extent permitted by available resources, including funding, flight access . . .
  - Identify the risks
  - Understand the risks
  - Manage the risks
    - Prevent them, OR
    - Reduce their effects to acceptable levels
      - To ensure safety, health and performance during and after space flight

The CPR Process

- Iterative approach of review, analysis and deliberation among discipline experts
- Focused on long duration, highly autonomous interplanetary missions such as a human expedition to Mars



Research Area Teams

NASA and NSBRI scientists formed working teams in

- **Human Adaptation and Countermeasures**
  - Bone Loss
  - Cardiovascular Alterations
  - Human Behavior & Performance
  - Immunology, Infection & Hematology
  - Muscle Atrophy and Alterations
  - Neurovascular Adaptation
  - Radiation Effects
- **Habitation Systems**
  - Advanced Life Support
  - Environmental Health
  - Food & Nutrition
  - Human Behavior & Performance
- **Health Care Systems**
  - Clinical Capabilities

Ranking the Risks

- Each research area team rank-ordered each of its risks using five criteria:
  - Probability of occurrence without countermeasures
  - Probability of occurrence with countermeasures
  - Severity of impact on accomplishing mission objectives
  - Severity of impact on crew health and safety

- Results of Risk Ranking
  - Identified 55 risks (across all risk areas)
  - Rank order #1 (including all risk areas): 17
  - Identified 361 critical questions
  - Priority #1 (including all risk areas): 125

Bioastronautics Research Facility

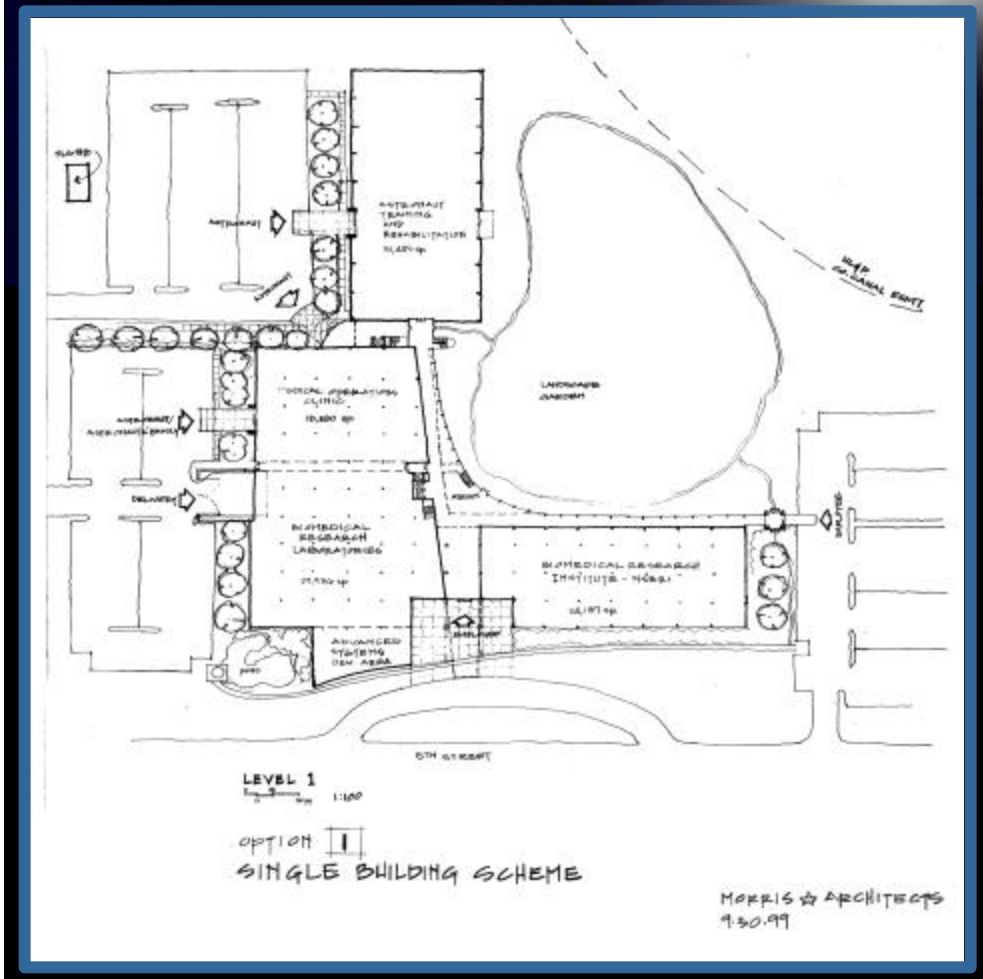
- An integrated, state-of-the art facility that provides overall support to
  - health care,
  - performance training,
  - rehabilitation,
  - research, and
  - educational outreach
- necessary to support the JSC Human Operations in Space mission while directly involving the NSBRI and the external scientific community

- Single, integrated facility that supports the specifics of human space flight
  - Space medicine
  - Biomedical research laboratories
  - Baseline data collection
  - Ground/flight research and operations integration
  - Human factors/bioengineering
  - Astronaut medical training
  - Advanced medical care
  - Systems/informatics research

Bioastronautics Approach

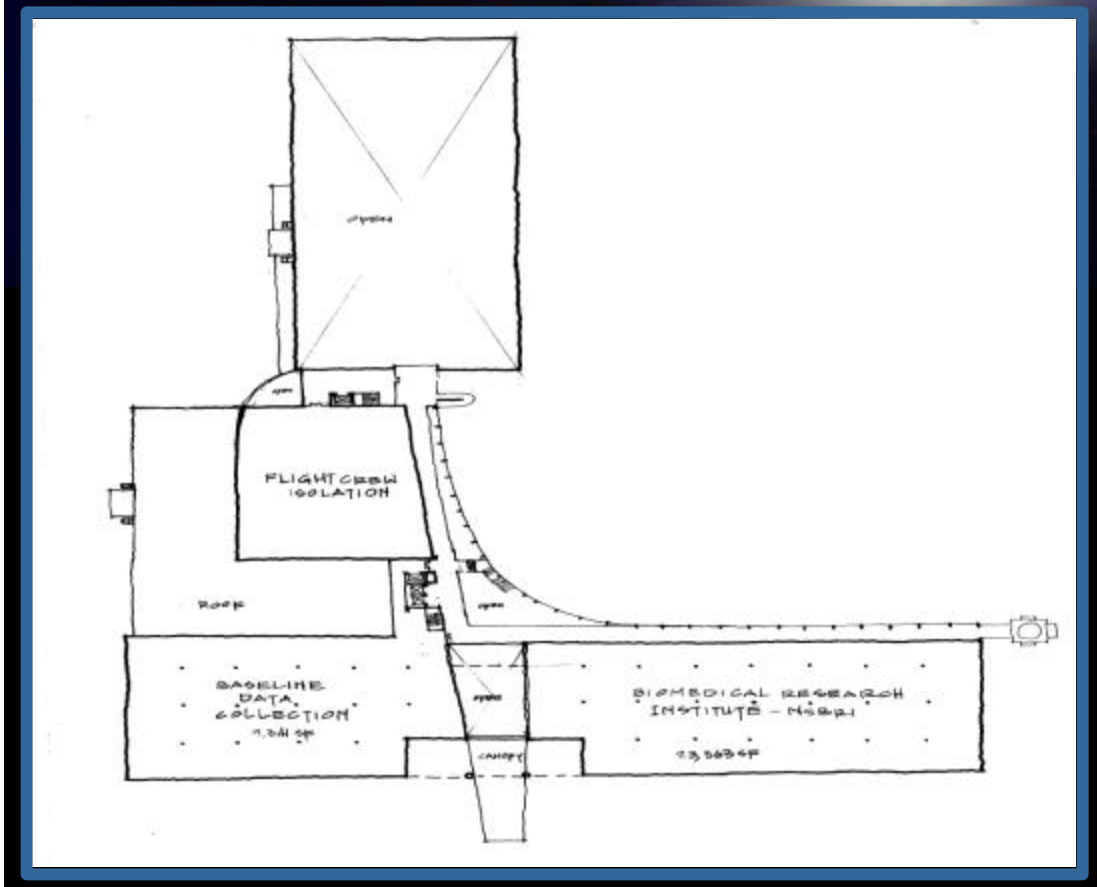
- Integrate the separate, but related, functions into an integrated complex
- Establish an environment where astronauts, medical professionals, scientists, engineers, and operations specialists can continually function as an integrated team
  - Modeled after the Woods Hole marine biology concept
- With NSBRI provide the facilities that support the development and implementation of a comprehensive biomedical research/countermeasure program that understands and mitigates the physical, physiological, and psychological risks associated with human space flight
- Provide an environment which brings the best scientific and technical minds in the Nation (and Internationally) together to understand and address the issues of human space flight
- Provide an educational environment which trains the next generation of space biomedical researchers, clinicians, and bioengineers

Bioastronautics Laboratory



- Biomedical Laboratory Wing
  - Biomedical Research Laboratories
  - Baseline Data Collection Facility
  - Flight Medicine Clinic
  - Crew Medical Training Facility
  - Advanced Biomedical/Clinical System Development Laboratory
- Astronaut Fitness and Re-Habilitation Wing
  - Aquatic Pre-flight Conditioning and Re-Habilitation Facility
  - Astronaut Fitness Maintenance Facility
  - Astronaut Isolation Facility
- NSBRI Biomedical Education Wing
  - Library/data/student/conference center
  - Research analysis, integration, and manifest support
- Building 37 (as part of overall complex)
  - Clinical analysis/environmental Laboratories
  - Cell/Tissue Engineering Laboratories
  - Astrobiology Laboratories (option under review)
  - Biologically Inspired Materials Laboratory (option under review)

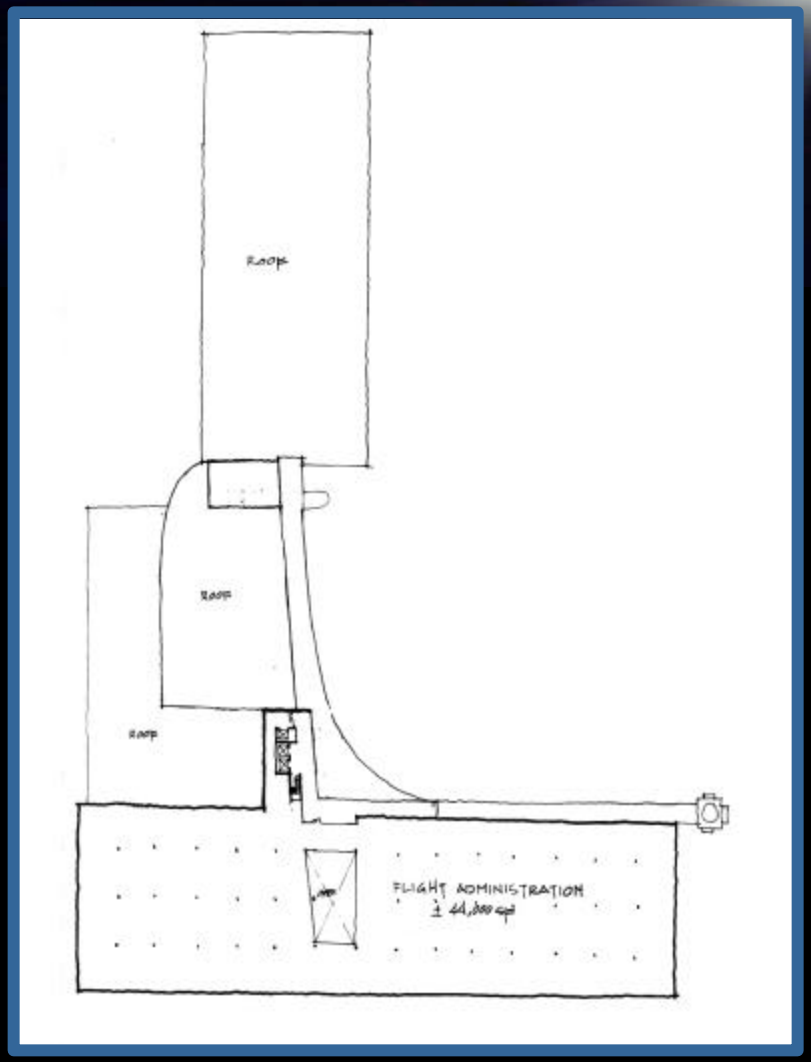
Bioastronautics Laboratory



Second Level

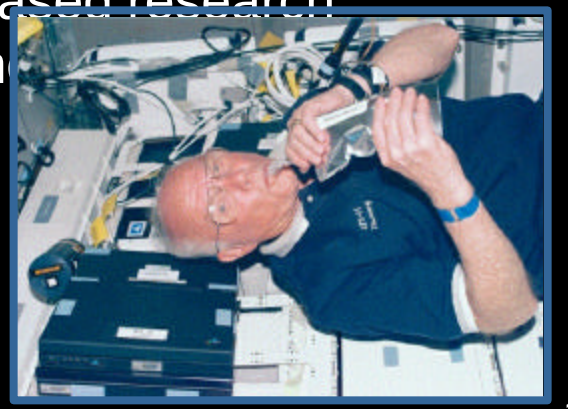
- Astronaut isolation
- Mission support and baseline data collection
- NSBRI

Bioastronautics Laboratory



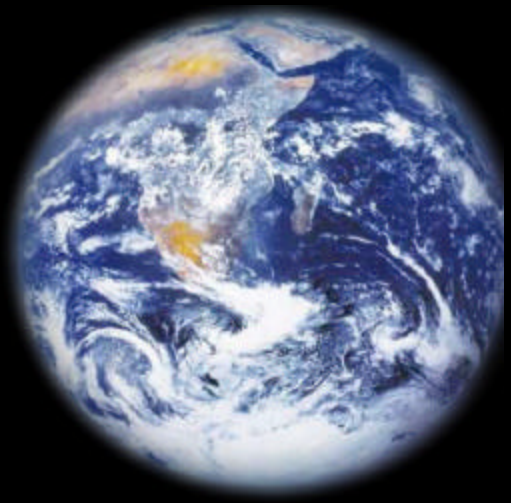
Third Level

- Shuttle mission and ISS increment management
- Flight & mission operations
- HLS experiment management
- Program interface
- Analytical and physical integration
- Science operations (telescience) support
- Ground-based research managem



Bioastronautics Facility Status

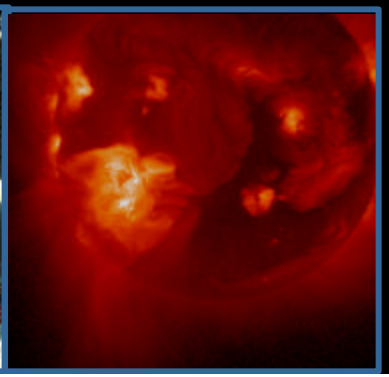
- Obtained and consolidated requirements
- Initiated internal/external approval process
- Reviewed initial building concepts
  - Single facility with inter-connecting wings
  - Approximately 250,000 square feet (gross)
  - ROM cost estimate $38,600,000 (+ $7-10M outfitting)
- Working with architects/customers to keep total costs < $50M
- Final design complete this year
- Construction in FY01-02



Decisions

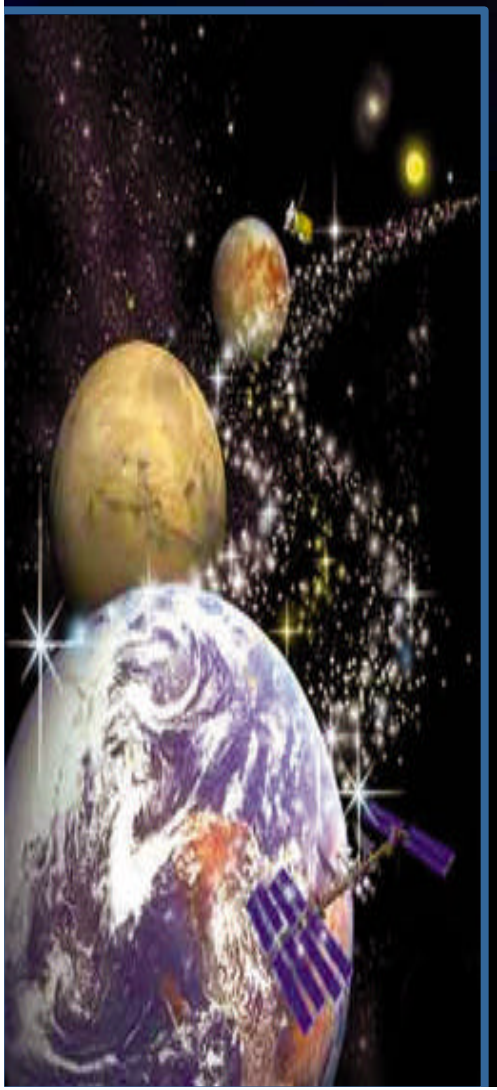
- The question of why it is necessary to build this facility on NASA property
  - Cost of land
  - Building 37 is an essential component of the complex (wet laboratories remain in 37 to keep building costs down)
  - Astronaut utilization of training and re-habilitation facility must be readily available to minimize time constraints of astronaut schedules
  - Facility includes an isolation facility that should remain within NASA property boundaries (facility could be expanded in future to include beyond low-Earth orbit isolation)



Summary

The Bioastronautics Facility



- Truly a unique opportunity to build on a solid base of NASA and non-NASA capabilities
  - Attract world-renown scientists and technologists
  - Leverage knowledge and technology to Earth based issues
- A new model for government and non-government partnerships
- Builds on NASA's original concept for "science institutes"
- Provides the synergism and critical mass necessary to ensure human health, safety, and performance, both for low-Earth orbit and beyond low-Earth orbit